WHAT I CLAIM IS:

1. A multi-resonant double-sided HTS magnetic dipole micro-antenna, comprising:

a first YBCO thin-film is patterned into a first curvilinear shape to provide a first

5 means for YBCO radiation on a top surface of an LAO substrate;

a second YBCO thin-film is patterned in a second curvilinear shape to provide a second means for YBCO radiation on a bottom surface of said LAO substrate;

said first YBCO radiating means generating a first magnetic flux;

said second YBCO radiation means generating a second magnetic flux;

10 said first YBCO radiation means and said second YBCO radiation means generating an inductive coupling by a magnetic dipole moment;

said first YBCO radiating means being configured so that at any one of a plurality half-cycles a first current flow is in phase with a second current flow in said second YBCO radiating means;

15 said first curvilinear shape and said second curvilinear shape each generate a circular polarization radiation pattern;

a discontinuity between said first YBCO radiation means and said second YBCO radiation means causes a plurality of multi-resonant properties;

said first YBCO radiation means, said second YBCO radiation means and said

20 LAO substrate provide a decreased surface impedance; and

said inductive coupling, said first current flow and said second current flow being in phase, said decreased surface impedance, said circular polarization radiation pattern and said plurality of multi-resonant properties permit a reduced antenna size with an increased antenna efficiency.

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2. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 1, further comprising said first YBCO thin-film being deposited to pattern said first curvilinear shape.

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3. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 2, further comprising said second YBCO thin-film being deposited to pattern said second curvilinear shape.

5   4. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 3, further comprising said second YBCO radiating means being configured so that at any one of the plurality of half-cycles said second current flow is in phase with said first current flow in said first YBCO radiating means.

10   5. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 4, further comprising said first magnetic flux being generated within said first curvilinear shape.

6. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as
15   recited in claim 5, further comprising and said second magnetic flux being generated within said second curvilinear shape.

7. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 6, further comprising said magnetic dipole moment having a given
20   magnitude.

8. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 7, further comprising said given magnitude being proportional to said first magnetic flux.

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9. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 8, further comprising said given magnitude being proportional to said second magnetic flux.

10. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 9, further comprising said decreased surface impedance being a superconductive property based on a temperature-dependent London penetration depth.

5   11. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 10, further comprising:

a voltage at any one of the plurality of half-cycles of said first YBCO radiating means results in a current flow in said second YBCO radiating means forming a radiation impedance, Z_{rad}, between said first YBCO radiating means and said second YBCO

10   radiating means;

said radiation impedance, Z_{rad}, prevents said current flow between said first YBCO radiating means, said second YBCO radiating means and the ground; and

said first YBCO radiating means and second YBCO radiation means preventing said micro-antenna from coupling with a plurality of surrounding objects.

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12. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 11, further comprising said LAO substrate being constructed of a single LaAlO$_3$ crystal with a loss-tangent of $tan\delta \approx 10^{-5}$.

20   13. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 12, further comprising said single LaAlO$_3$ crystal having a dielectric constant of about 24.

14. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna,

25   as recited in claim 13, further comprising said first YBCO radiating means having a T$_c$ of about 92 Kelvin.

15. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 14, further comprising said second YBCO radiating means having a T$_c$

30   of about 92 Kelvin.

16. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 15, further comprising said first curvilinear shape being a first spiral.

17. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 16, further comprising said second curvilinear shape being a second spiral.

18. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 16, further comprising said first spiral being a multiple-turn Archimedean spiral.

19. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 17, further comprising said second spiral being said multiple-turn Archimedean spiral.

20. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 15, further comprising said first curvilinear shape being a first plurality of concentric rings.

21. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 20, further comprising said first plurality of concentric rings being arranged into a plurality of top ring clusters.

22. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 21, further comprising each of said plurality of top ring clusters being separated by a top cluster gap.

23. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 22, further comprising each of said first plurality of concentric rings being separated by a top ring gap.

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24. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 20, further comprising said second curvilinear shape being a second plurality of concentric rings.

5   25. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 24, further comprising said second plurality of concentric rings being arranged into a plurality of bottom ring clusters.

26. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as
10   recited in claim 25, further comprising each of said plurality of bottom ring clusters being separated by a bottom cluster gap.

27. The multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 26, further comprising each of said second plurality of concentric rings
15   being separated by a bottom ring gap.

28. A multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, comprising:
        a first YBCO thin-film is patterned into a first plurality of spiral loops to provide
20   a first means for YBCO radiation on a top surface of an LAO substrate;
        a second YBCO thin-film is patterned into a second plurality of spiral loops to provide a second means for YBCO radiation on a bottom surface of said LAO substrate;
        said first YBCO radiating means generating a first magnetic flux;
        said second YBCO radiation means generating a second magnetic flux;
25   said first YBCO radiating means and said second YBCO radiating means generating an inductive coupling by a magnetic dipole moment;
        said first YBCO radiating means being configured so that at any one of a plurality half-cycles a first current flow is in phase with a second current flow in said second YBCO radiating means;
30   said first plurality of spiral loops and said second plurality of spiral loops each generate a circular polarization radiation pattern;

a discontinuity between said first YBCO radiation means and said second YBCO radiation means causes a plurality of multi-resonant properties;

said first YBCO radiation means, said second YBCO radiation means and said LAO substrate provide a decreased surface impedance; and

said inductive coupling, said first current flow and said second current flow being in phase, said decreased surface impedance, said circular polarization radiation pattern and said plurality of multi-resonant properties permit a reduced antenna size with an increased antenna efficiency.

29. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 28, further comprising said first YBCO thin-film being deposited to pattern said first plurality of spiral loops.

30. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 29, further comprising said second YBCO thin-film being deposited to pattern said second plurality of spiral loops.

31. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 30, further comprising said second YBCO radiating means being configured so that at any one of the plurality of half-cycles said second current flow is in phase with said first current flow in said first YBCO radiating means.

32. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 31, further comprising said first magnetic flux being generated within said first plurality of spiral loops.

33. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 32, further comprising and said second magnetic flux being generated within said second plurality of spiral loops.

34. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 33, further comprising said magnetic dipole moment having a given magnitude.

5   35. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 34, further comprising said given magnitude being proportional to said first magnetic flux.

36. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, 10   as recited in claim 35, further comprising said given magnitude being proportional to said second magnetic flux.

37. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 36, further comprising said decreased surface impedance being a 15   superconductive property based on a temperature-dependent London penetration depth.

38. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 37, further comprising:
       a voltage at any one of the plurality of half-cycles of said first YBCO radiating 20   means results in a current flow in said second YBCO radiating means forming a radiation impedance, Z_{rad}, between said first YBCO radiating means and said second YBCO radiating means;
       said radiation impedance, Z_{rad}, prevents said current flow between said first YBCO radiating means, said second YBCO radiating means and the ground; and
25   said first YBCO radiating means and second YBCO radiation means preventing said micro-antenna from coupling with a plurality of surrounding objects.

39. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 38, further comprising said LAO substrate being constructed of a 30   single $LaAlO_3$ crystal with a loss-tangent of $tan\delta \approx 10^{-5}$.

40. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 39, further comprising said single $LaAlO_3$ crystal having a dielectric constant of about 24.

5   41. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 40, further comprising said first YBCO radiating means having a T_c of about 92 Kelvin.

42. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, 10   as recited in claim 41, further comprising said second YBCO radiating means having a T_c of about 92 Kelvin.

43. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 42, further comprising said first YBCO radiating means being shaped 15   into a multiple-turn Archimedean spiral.

44. The multi-resonant double-sided spiral HTS magnetic dipole micro-antenna, as recited in claim 43, further comprising said second YBCO radiating means being shaped into a multiple-turn Archimedean spiral.
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45. A multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, comprising:
      a first YBCO thin-film is patterned into a first plurality of concentric rings to provide a first means for YBCO radiation on a top surface of an LAO substrate;
25   a second YBCO thin-film is patterned in a second plurality of concentric rings to provide a second means for YBCO radiation on a bottom surface of said LAO substrate;
      said first YBCO radiating means generating a first magnetic flux;
      said second YBCO radiation means generating a second magnetic flux;
      said first YBCO radiation means and said second YBCO radiation means
30   generating an inductive coupling by a magnetic dipole moment;

said first YBCO radiating means being configured so that at any one of a plurality half-cycles a first current flow is in phase with a second current flow in said second YBCO radiating means;

said first plurality of concentric rings and said second plurality of concentric rings each generate a circular polarization radiation pattern;

a discontinuity between said first YBCO radiation means and said second YBCO radiation means causes a plurality of multi-resonant properties;

said first YBCO radiation means, said second YBCO radiation means and said LAO substrate provide a decreased surface impedance; and

said inductive coupling, said first current flow and said second current flow being in phase, said decreased surface impedance, said circular polarization radiation pattern and said plurality of multi-resonant properties permit a reduced antenna size with an increased antenna efficiency.

46. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 45, further comprising said first YBCO thin-film being deposited to pattern said first plurality of concentric rings.

47. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 46, further comprising said second YBCO thin-film being deposited to pattern said second plurality of concentric rings.

48. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 47, further comprising said second YBCO radiating means being configured so that at any one of the plurality of half-cycles said second current flow is in phase with said first current flow in said first YBCO radiating means.

49. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 48, further comprising said first magnetic flux being generated within said first plurality of concentric rings.

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50. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 49, further comprising and said second magnetic flux being generated within said second plurality of concentric rings.

5   51. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 50, further comprising said magnetic dipole moment having a given magnitude.

52. The multi-resonant double-sided folded log-periodic HTS magnetic dipole
10   micro-antenna, as recited in claim 51, further comprising said given magnitude being proportional to said first magnetic flux.

53. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 52, further comprising said given magnitude being
15   proportional to said second magnetic flux.

54. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 53, further comprising said decreased surface impedance being a superconductive property based on a temperature-dependent London
20   penetration depth.

55. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 54, further comprising:
        a voltage at any one of the plurality of half-cycles of said first YBCO radiating
25   means results in a current flow in said second YBCO radiating means forming a radiation impedance, Z_{rad}, between said first YBCO radiating means and said second YBCO radiating means;
        said radiation impedance, Z_{rad}, prevents said current flow between said first YBCO radiating means, said second YBCO radiating means and the ground; and
30   said first YBCO radiating means and second YBCO radiation means preventing said micro-antenna from coupling with a plurality of surrounding objects.

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56. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 54, further comprising said LAO substrate being constructed of a single $LaAlO_3$ crystal with a loss-tangent of $tan\delta \approx 10^{-5}$..

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57. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 56, further comprising said single $LaAlO_3$ crystal having a dielectric constant of about 24.

58. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 57, further comprising said first YBCO radiating means having a T_c of about 92 Kelvin.

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59. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 58, further comprising said second YBCO radiating means having a T_c of about 92 Kelvin.

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60. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 59, further comprising said first plurality of concentric rings being arranged into a plurality of top ring clusters.

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61. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 60, further comprising each of said plurality of top ring clusters being separated by a top cluster gap.

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62. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 61, further comprising each of said first plurality of concentric rings being separated by a top ring gap.

63. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 62, further comprising said second plurality of concentric rings being arranged into a plurality of bottom ring clusters.

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64. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 63, further comprising each of said plurality of bottom ring clusters being separated by a bottom cluster gap.

5   65. The multi-resonant double-sided folded log-periodic HTS magnetic dipole micro-antenna, as recited in claim 64, further comprising each of said second plurality of concentric rings being separated by a bottom ring gap.

         66. A method for reducing antenna length with a multi-resonant double-sided
10   HTS magnetic dipole micro-antenna, comprising the steps of:
         depositing a first YBCO thin-film on a top surface of an LAO substrate;
         depositing a second YBCO thin-film on a bottom surface of said LAO substrate;
         forming a first means for YBCO radiation by patterning said first YBCO thin-film on said top surface into a first curvilinear shape;
15   forming a second means for YBCO radiation by patterning said second YBCO thin-film on said bottom surface in a second curvilinear shape;
         generating a first magnetic flux within said first YBCO radiating means;
         generating a second magnetic flux within said second YBCO radiation means;
         generating an inductive coupling by a magnetic dipole moment from said first
20   YBCO radiation means and said second YBCO radiation means;
         configuring said first YBCO radiating means so that at any one of a plurality half-cycles a first current flow is in phase with a second current flow in said second YBCO radiating means;
         generating a circular polarization radiation pattern in said first curvilinear shape
25   and said second curvilinear shape;
         causing a plurality of multi-resonant properties by a discontinuity between said first YBCO radiation means and said second YBCO radiation means;
         providing a decreased surface impedance due to the interaction of said first YBCO radiating means, said second YBCO radiating means and said LAO substrate; and
30   permitting a reduced antenna size with an increased antenna efficiency due to said inductive coupling, said first current flow and said second current flow being in phase,

said decreased surface impedance, said circular polarization radiation pattern and said plurality of multi-resonant properties.

67. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 66, further comprising the step of configuring said second YBCO radiating means so that at any one of the plurality of half-cycles said second current flow is in phase with said first current flow in said first YBCO radiating means.

68. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 67, further comprising the step of generating said first magnetic flux within said first curvilinear shape.

69. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 68, further comprising the step of generating and said second magnetic flux within said second curvilinear shape.

70. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 69, further comprising the step of providing said magnetic dipole moment with a given magnitude.

71. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 70, further comprising the step of providing said given magnitude as proportional to said first magnetic flux.

72. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 71, further comprising the step of providing said given magnitude as proportional to said second magnetic flux.

73. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 72, wherein said decreased

surface impedance is a superconductive property based on a temperature-dependent London penetration depth.

74. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 73, further comprising the steps of:

forming a radiation impedance, Z_{rad}, between said first YBCO radiating means and said second YBCO radiating means when a voltage at any one of the plurality of half-cycles of said first YBCO radiating means results in a current flow in said second YBCO radiating means;

said radiation impedance, Z_{rad}, preventing said current flow between said first YBCO radiating means, said second YBCO radiating means and the ground; and

said first YBCO radiating means and second YBCO radiation means preventing said micro-antenna from coupling with a plurality of surrounding objects.

75. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 74, further comprising the step of constructing said LAO substrate from a single $LaAlO_3$ crystal with a loss-tangent of $tan\delta \approx 10^{-5}$.

76. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 75, further comprising the step of forming said single $LaAlO_3$ crystal with a dielectric constant of about 24.

77. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 76, further comprising the step of providing said first YBCO radiating means with a T_c of about 92 Kelvin.

78. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 77, further comprising the step of providing said second YBCO radiating means with a T_c of about 92 Kelvin.

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79. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 78, further comprising the step of forming said first curvilinear shape into a first spiral.

5   80. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 79, further comprising the step of forming said second curvilinear shape into a second spiral.

81. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 79, further comprising the step
10   of forming said first spiral into a multiple-turn Archimedean spiral.

82. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 80, further comprising the step
15   of forming said second spiral into a multiple-turn Archimedean spiral.

83. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 78, further comprising the step of forming said first curvilinear shape into a first plurality of concentric rings.
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84. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 83, further comprising the step of arranging said first plurality of concentric rings into a plurality of top ring clusters.

25   85. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 84, further comprising the step of separating each of said plurality of top ring clusters with a top cluster gap.

86. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 85, further comprising the step
30   of separating each of said first plurality of concentric rings with a top ring gap.

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87. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 83, further comprising the step of forming said second curvilinear shape into a second plurality of concentric rings.

5   88. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 87, further comprising the step of arranging said second plurality of concentric rings into a plurality of bottom ring clusters.

10   89. The method for reducing antenna length with a multi-resonant double-sided HTS magnetic dipole micro-antenna, as recited in claim 88, further comprising the step of separating each of said plurality of bottom ring clusters with a bottom cluster gap.

90. The method for reducing antenna length with a multi-resonant double-sided
15   HTS magnetic dipole micro-antenna, as recited in claim 89, further comprising the step of separating each of said second plurality of concentric rings being with a bottom ring gap.